

# The real effectiveness of ultrasound guidance in subclavian venous access



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## The real effectiveness of ultrasound guidance in subclavian venous access

**AIM:** *The technique of ultrasound-guided subclavian cannulation was evaluated in our experience assessing the real effectiveness of such procedure.*

**METHODS:** *We have evaluated 297 subclavian cannulation, performed for the placement of central venous catheter both with landmark method (176 patients) and ultrasound guided technique (121 patients) to assess the real effectiveness of the ultrasound-guided technique to reduce the mechanical complication of the subclavian vein puncture.*

**RESULTS:** *A total of 23 mechanical complications were identified. Of these, 8 were pneumothorax and 15 arterial puncture. Such cases were identified from the pool of patients who had undergone subclavian venous cannulation with landmark method. However these complications occurred only in difficult venous access and teaching procedure performed with landmark method.*

**DISCUSSION:** *An ultrasound-guided recent technique for the placement of central venous access should be adopted since such technique seems to reduce the incidence of failure and mechanical complications. However it is worth notice that the clinical effect of using ultrasound guidance technique seems to be more significant when the internal jugular vein rather than the subclavian vein is cannulated.*

**CONCLUSION:** *Our experience demonstrate that, both in no difficult cases and in no teaching procedures, central venous catheterization using landmark technique seems to be acceptable on both clinical and medico-legal grounds. However the ultrasound guided technique is necessarily required to achieve the reduction of complications in difficult venous access.*

**KEY WORDS:** Complications, Landmark, Subclavian, Ultrasound, Venous access.

## Introduction

Central venous catheterization is frequently required in hospitalized patients. Central venous access has a paramount role throughout the management of many patients, as they are needed for hemodynamic monitor-

ing, delivery of blood products (chemotherapy and antibiotics), hemodialysis, total parental nutrition and management of perioperative fluids. All central venous catheters require an access through tributary branches of the vena cava so that their tip is placed correctly in the central venous district. The two most commonly used sites for access are the internal jugular vein and the subclavian vein<sup>1-3</sup>.

An ultrasound-guided recent technique for the placement of central venous access should be adopted since such technique seems to reduce the incidence of failure and mechanical complications<sup>2,3</sup>.

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It is worth notice that the clinical effect of using ultrasound guided technique seems to be more significant when the internal jugular vein rather than the subclavian vein is cannulated.

The technique of ultrasound-guided subclavian cannulation was evaluated in our experience assessing the real effectiveness of such procedure.

## Materials and methods

This is a retrospective study. A chart review was performed on all patients requiring central venous access between January 2004 and December 2009 that had undergone percutaneous subclavian cannulation.

We have performed 297 subclavian cannulation for the placement of central venous catheter both with landmark method (176 patients) and ultrasound guided technique (121 patients).

Regarding our standard operative technique we use the percutaneous approach. In the landmark method the safe puncture of subclavian vein is achieved using the anticipated line of the vein on the skin's surface. In the ultrasound guided technique a sterile linear 10Mhz transducer is placed up to the middle third of the clavicle (in the jugular fossa) by another operator. The subclavian vein is then located by angling the transducer inferiorly until the vessel is clearly seen (Fig. 1). The needle is introduced under ultrasound guidance and the wall of the vein can be seen to tent before it is punctured under vision.

The aim of this study is to assess the real effectiveness of the ultrasound-guided technique to reduce the mechanical complication of the subclavian vein puncture.

Statistical analysis was performed with S.P.S.S 14.0. The Yates corrected  $\chi^2$  test was used as a means of evaluating differences in categorical variables. Statistical significance was accepted when the *P* value was less than 0,05.



Fig. 1: Ultrasound guided technique.

## Results

A total of 23 mechanical complications were identified from the pool of 176 patients who had undergone subclavian venous cannulation with landmark method while no complication was identified from the pool of 121 patients who undergone ultrasound-guided insertion of subclavian venous catheter. Of these, 8 were pneumothorax and 15 arterial puncture. All pneumothorax was successfully treated with thoracic drainage while only an arterial puncture caused hemothorax and needed a thoracic drainage. In such cases surgery was not needed and hospital discharge was obtained after an average hospital stay of 7±2 days. The analysis demonstrates a statistical significance ( $p = 0.01$  for pneumothorax and  $p = 0.001$  for arterial puncture) in favour of the ultrasound-guided technique.

Therefore we have evaluated the features of each procedure performed both with landmark method and with ultrasound guided technique and we have included in another analysis only the difficult venous access and the procedure performed by inexperienced operator (the first 50 teaching procedure). Among these cases, 39 difficult venous access and 16 teaching procedure were performed with landmark method while 43 difficult venous access and 9 teaching procedure were performed with ultrasound-guided technique. With reference to such cases, the analysis demonstrates a statistical significance with respect to complications and needed time in favour of the ultrasound guided technique (Tab. 1).

Conversely NO complications were identified when subclavian venous access was achieved in other patients (190 patients) without venous access difficulties, threaded both with landmark method and ultrasound-guided technique. Moreover the time needed for such procedure was the same (159±25sec vs 160±27sec).

## Discussion

The safe puncture of a central vein is traditionally achieved by passing the needle along the anticipated line of the vein using anatomical landmarks on the skin's surface (the landmark method)<sup>1,4</sup>. The percutaneous approach to the subclavian or internal jugular vein is currently the most popular procedure for placing catheters in the superior vena cava. The great flexibility of percutaneous cannulation, the short duration of the procedure in most situations, and the possibility to switch from a procedure that requires an operating theatre to a less demanding (especially cost-wise) outpatient or even bed-side procedure have made the superiority of percutaneous central vein access quite obvious<sup>1</sup>. However, anatomic studies have demonstrated a significant degree of variability in the relation between the target vein and the surrounding landmarks<sup>5,6</sup>. Complications of central venous access can range from

Table I - Patients and results of the difficult venous access

Ultrasound-guided technique		Landmark method		P value
Difficult venous access	39	Difficult venous access	43	P=0.14
obesity	18	obesity	22	
local surgery	3	local surgery	5	
short of breath	6	short of breath	5	
vascular abnormality	8	vascular abnormality	6	
bone abnormality	4	bone abnormality	3	
Teaching procedure	9	Teaching procedure	16	P=0.61
Complications		Complications		
Pneumothorax	0	Pneumothorax	8	p=0.008
Arterial puncture	0	Arterial puncture	15	p=0.001
Time request (sec)	154±25	Time request (sec)	447±298	p=0.04

minor to catastrophic. Complication rates up to 15% have been reported, although major or life-threatening complications are less common <sup>2,7</sup>. The most common and major mechanical complications during the insertion of needle in central venous system are arterial puncture and pneumothorax. Arterial puncture occurs in approximately 6.3% to 9.4% for internal jugular access and in approximately 3.1% to 4.9% for subclavian access. Pneumothorax occurs in approximately 0.1% to 0.2 % for internal jugular access and in approximately 1.5% to 3.1% for subclavian access <sup>1,8,9</sup>.

Ultrasound imaging localization has been proposed as a method to increase the success rate and decrease the complication rate associated with central venous catheter placement <sup>1</sup>. Indeed the only procedure that has been evaluated in randomized and controlled clinical trials, which have been pooled in 3 meta-analyses <sup>10-12</sup>, is the ultrasound-guided placement of central venous access (technique adopted for both the subclavian and internal jugular vein). According to this technique, an ultrasound probe is used to locate the vein, and the introducer needle is guided through the skin and into the vessel.

The literature supporting the use of ultrasound for central venous access by the internal jugular veins is compelling <sup>1,2,4,12,19</sup>, but there is far less information available to support its use for other routes of access <sup>1-2,14,15</sup>. There is convincing evidence that the use of ultrasound for real-time guidance by trained operators during internal jugular line placement involves an increase success rate and decrease complication rates <sup>16-18</sup>. Conversely, the data for subclavian line placement are less clear, with a recent review citing 4 studies supporting ultrasound and 2 studies showing no improvement <sup>19</sup>.

Our experience demonstrates that the ultrasound-guided technique is more effective than landmark method in reducing complications when the venous access is obtained in teaching procedure (inexperience operator) or in difficult venous access.

The literature confirms that complications are influenced by patient factors, site of attempted access and operator experience. Operator experience is considered by (almost) all authors to be determinant of pneumothorax rate. Consequently, the operator learning curve (approximately up to 50 implants) has a major impact on complication rate and should be considered when the complication prevalence is assessed <sup>1,2</sup>. Previous authors have established a list of patient criteria for anticipated difficult access: surface landmarks difficult of identification (e.g. obesity, local swelling, bone abnormality), limited sites for access attempts (e.g. other catheters, pacemaker, local surgery or infection), previous difficulties during catheterization, previous complication, known vascular abnormality, coagulopathy-uncorrected and patient unable to tolerate supine position (e.g. short of breath, increased intracranial pressure).

Furthermore their observations <sup>4,20,21</sup> and our experience support the use of ultrasound guided technique in difficult cases of central venous catheterization. Infact in such cases the ultrasound guidance is necessarily required to achieve the reduction of complications. Nevertheless our experience demonstrates NO usefulness when subclavian venous access was achieved in patients without venous access difficulties. Therefore in our opinion, both in no difficult case and in no teaching procedures, central venous catheterization using landmark technique seems to be acceptable on both clinical and medico-legal grounds. On the other hand, in cases in which a difficult vein access is identified in advance, it seems to be demonstrated that the ultrasound guided technique shall be used in order to reduce the complication rate.

Further research is needed before drawing definitive conclusions regarding management of such site access of central venous cannulation; our study size was limited, and further outcome studies are needed.

## Riassunto

Il posizionamento di un catetere venoso centrale richiede un accesso percutaneo attraverso le tributarie della vena cava. I siti di accesso venoso più comuni ed utilizzati sono la vena giugulare e la vena succlavia. Recentemente, è stata introdotta una tecnica eco-guidata per il posizionamento di un accesso venoso centrale con lo scopo di ridurre l'incidenza dei fallimenti e delle complicanze meccaniche (pneumotorace e puntura arteriosa accidentale). È noto che i vantaggi di tale metodica sono maggiormente significativi quando è coinvolta la vena giugulare piuttosto che la vena succlavia. Abbiamo, quindi, valutato 297 posizionamenti di cateteri in vena succlavia, eseguiti sia con tecnica tradizionale (176) che con tecnica eco-guidata (121 pazienti) per determinare la reale efficacia della tecnica ecografica nella riduzione delle complicanze meccaniche. I risultati ottenuti evidenziano l'insorgenza di 23 complicanze nel gruppo di pazienti sottoposti a procedura tradizionale; di cui 8 pneumotoraci e 15 punture accidentali di arteria. Tuttavia le suddette complicanze si verificano esclusivamente in accessi venosi difficili e in procedure eseguite da operatori inesperti. La nostra esperienza dimostra, quindi, come supportato dalla letteratura, che in accessi venosi non difficili e con operatori esperti la tecnica di puntura venosa tradizionale è tuttora valida sia ad una valutazione clinica che medico-legale. Tuttavia la guida ecografica è indispensabile negli accessi venosi difficili per ottenere la riduzione delle complicanze.

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